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Used Oil Characterizaton Study

Solid and Hazardous Waste Program

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ABSTRACT

Nine used oil samples were collected at processor/blender/marketer sites in Western Washington between October and November 1990, and tested for various characteristics and criteria to determine whether used oil is a dangerous waste as defined by the Dangerous Waste Regulations, Chapter 173-303 WAC. All samples were collected from businesses which either blend or market used oil. The used oil samples were analyzed for: metals, volatile, and semi-volatiles organic compounds using the Toxicity Characteristic Leaching Procedure (TCLP); halogenated hydrocarbons; and fish toxicity (a static acute test using salmonids). All nine samples were tested for the TCLP organics and for halogenated hydrocarbons. Six samples were tested for fish toxicity. Benzene was found at levels exceeding the TC regulatory limit in two out of nine samples. Halogenated hydrocarbons were found at levels exceeding the regulatory limit of 100 ppm in nine out of nine samples. Three out nine samples exceeded the regulatory criteria (i.e. 1000 ppm, halogenated hydrocarbons) for burning for used oil energy recovery. One out of six samples tested in the acute fish toxicity test was found to exceed the regulatory limit. Recommendations are made for several possible Department of Ecology actions as a result of these findings.

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INTRODUCTION

"Waste oil" or "used oil" means oil that has been refined from crude oil, used, and as a result of such use, is contaminated by physical or chemical impurities. Used oils are generated by many industrial processes, but the largest source by far is the transportation sector. Spent automotive crankcase oil is the leading source of Washington's used oil stream. It is estimated (Problem Waste Study) that the volume of used oil generated in the transportation industry and by do-it-yourselfers is some 22 million gallons each year. Used oil represents a substantial waste stream that is a concern from a regulatory and waste management standpoint.

Used oil has been tested for metals, halogenated hydrocarbons (chlorinated solvents), volatile and semi-volatile organics, and aquatic toxicity in various studies. Available data have suggested that used oil may sometimes contain halogenated hydrocarbons in concentrations exceeding the regulatory limit.

Used oil with halogenated hydrocarbons in concentrations exceeding 100 ppm is a persistent dangerous waste under WAC 173-303-102. Used oil with halogenated hydrocarbons in concentrations up to 1000 ppm is excluded from management as a dangerous waste provided it is burned for energy recovery in accordance with WAC 173-303-515. While it is known that some used oil exceeds the 1000 ppm limit for halogenated hydrocarbons, Ecology was interested in the percent of time the 1000 ppm criteria was exceeded. In addition, Ecology was interested in whether used oil was a dangerous waste for reasons other than halogenated hydrocarbons.

Clarification of the status of used oil under the newly adopted Toxicity Characteristic (TC) rule, WAC 173-303-090(8), was a primary focus of this study in order to develop a statewide used oil management policy. Ecology's Solid and Hazardous Waste Program, therefore, conducted a study of a limited number of used oil samples collected from used oil processors, blenders, and marketers. Only data generated in this study is included in this report.

COMPOSITION AND USE OF USED OIL

The chemical composition of lubricating oils, as with all other petroleum products, varies with the crude-oil source, the refining process and the additives present. The manufacturing process of lubricating oil has changed significantly in recent years in order to eliminate undesirable compounds, such as polycyclic aromatic hydrocarbons (PAH).

Generally, aliphatic compounds represent between 73% and 80% of the total weight of the oil. This fraction is composed of alkanes and cycloalkanes of 1-6 rings. Monoaromatic hydrocarbons make up 11% to 15% of the weight, diaromatics 2% to 5%, and polyaromatic and polar fractions 4% to 8%. The polar fraction is made up of aromatic compounds which contain sulphur, nitrogen, or oxygen. During oil fabrication, and in order to improve its physical and chemical properties, several types of additives are employed. The different types of additives include some chemical modifiers and some physical modifiers. The chemical modifiers include; boundary lubrication additives (wear inhibitors, friction modifiers, lubricity agents, extreme pressure agents); corrosion inhibitors; oxidation inhibitors; and detergents and dispersants. The physical modifiers include; viscosity modifiers (viscosity index improvers, thickeners); pour point depressants; emulsion modifiers; foam decomposers; tackiness agents; and dyes.

The additive content of lubricating oils can be as much as 25%, the most important being detergents and dispersants at 2% to 15% of the weight of the oil. Of the oil additives, several compounds are known to be dangerous environmental contaminants. Zinc diaryl or dialkyl dithiophosphates; molybdenum disulphide; zinc dithiophosphate; heavy-metal soaps and other organometallic compounds which contain heavy metals. New motor oil typically contains in the range of 1500 ppm of zinc, and 87 ppb of cadmium.

During motor operation, lubricating oil is chemically transformed by oxidation, nitration, cracking of polymers, decomposition of organometallic compounds, etc. This change is due to the high temperature and the high mechanical strains that the oil is subjected to during motor operation. In addition, motor oil accumulates different contaminants, such as fuel (gasoline or diesel), water, antifreeze, and insoluble particles.

One of the more important differences between new and used motor oil is the heavy metal content. The metal content of used motor oil is very important, because many of these metals are potentially dangerous to living organisms. These metals originate from the fuel and from motor wear. Used motor oil contains Pb, Zn, Ca, Ba, and Mg, and to a lesser extent Fe, Na, Cu, Al, Cr, Mn, K, Ni, Sn, Si, B, and Mo. The concentration of metals in lubricating oil increases with motor operating time and the amount is dependent on fuel type and the mechanical condition of the engine.

Other types of compounds present in used motor oil are polycyclic aromatic hydrocarbons (PAH), which are dangerous to human health because some are known to cause cancer, and others are known to be mutagenic. The PAH content of new motor oil is relatively low, but increases with motor operating time. The PAH content of used motor oil from gasoline engines can be 180 times higher than that of new motor oil, and the concentration of benzo[a]pyrene in used crankcase oil can be 1000 times higher than that in new oils.

Motor oil contains many additives which modify either the chemical or mechanical properties of the base lube stock to enhance the performance of lubricating oil operating under high temperatures and high mechanical stress. The additives include viscosity index improvers, ashless dispersants, detergents, antiwear agents, extreme pressure (EP) agents, corrosion inhibitors, pour point depressants, antioxidents, friction modifiers, biocides, emulsifiers, antifoamants, and others. Some of the common additive types and the typical chemical compounds included in the additives are listed in Table 1. Chlorinated parafins have been suspected as the cause of the elevated halogenated hydrocarbon content of used oil. While chlorinated parafins are used in gear lubes, they are not used as an additive in motor oils.

Table 1. Surface Protective Additives - Automotive Lubricants

Additive Type: Antiwear and EP Agent. Purpose: Reduce friction and wear and prevent scouring and seizure. Function: Chemical reaction with metal surface to form a film with lower shear strength than the metal, thereby preventing metal to metal contact.	Typical Compounds: Zinc dithiophosphates, organic phosphates, and acid organic sulfur and chlorine compounds, sulfurized fats, sulfides and disulfides.
Additive Type: Corrosion and Rust Inhibitor. Purpose: Prevent corrosion and trusting of metal parts in contact with the lubricant. Function: Preferential adsorption of polar constituent on metal surface to provide a protective film and/or neutralization of corrosive acids	Typical Compounds: Zinc dithiophosphates, metal phenolates, basic metal sulfonates, fatty acids and amines.
Additive Type: Detergent. Purpose: Keep surfaces free of deposits. Function: Chemical reaction with sludge and varnish precursors to neutral-ize them and keep them soluble.	Typical Compounds: Metallo-organic compounds of barium, calcium, and magnesium phenolates, phosphates, and sulfonates.

Table 1. (continued)

Additive Type: Dispersant. Purpose: Keep insoluble contaminants dispersed in the lubricant. Function: Contaminants are bonded by polar attraction to dispersant molecules, prevented from agglomerating and kept in suspension due to solubility of dispersant.	Typical Compounds: Polymeric alkylthiophosphates and allkylsuccinimides.
Additive Type: Friction Modifier. Purpose: Alter coefficient of friction. Function: Preferential adsorption of surface-active materials.	Typical Compounds: Organic fatty acids and amines, lard oil, high molecular weight organic phosphorus and phosphoric acid esters.
Additive Type: Pour Point Depressant. Purpose: Enable lubricant to flow at low temperatures. Function: Modify wax crystal formation to reduce interlocking.	Typical Compounds: Alkylated naphthalene and phenolic polymers, poly-methacrylates.
Additive Type: Seal Swell Agent. Purpose: Swell elastomeric seals. Function: Chemical reaction with elasto-mer to cause slight swell.	Typical Compounds: Organic phosphates and aromatic hydrocarbons.
Additive Type: Viscosity Improver. Purpose: Reduce the rate of viscosity change with temperature. Function: Polymers expand with increasing temperature to counteract oil thinning.	Typical Compounds: polymers and copolymers of methacrylates, butadiene, olefins, and akylated styrenes
Additive Type: Antifomant. Purpose: Prevent lubricant from forming a persistent foam. Function: Reduce surface tension to speed collapse of foam.	Typical Compounds: Silicone polymers, organic copolymers.

Table 1 (continued)

Additive Type: Antioxidant. Purpose: Retard oxidative decomposition. Function: Decompose peroxides and terminate free-redical reactions.	Typical Compounds: Zinc dithiophosphates, hindered phenols, aromatic amines, sulfurized phenols.
Additive Type: Metal Deactivator. Purpose: Reduce catalytic effect of metals on oxidation rate. Function: Form inactive film on metal surfaces by complexing with metallic ions.	Typical Compounds: Organic complexes containing nitrogen or sulfur, amines, sulfides, and phosphites.

METHODS

Sampling

To characterize used oil under Washington's Dangerous Waste regulations, representative samples were collected from nine processors/blenders/marketers and subjected to analysis. The samples were analyzed for TCLP volatiles and semi-volatiles, halogenated hydrocarbons, and for fish toxicity. These tests were selected for used oil because it was believed that they would provide the most information regarding the status of this waste.

Site Selection. A total of nine samples were collected during the course of the study. The marketer/blender samples were collected from large tanks at the processor/blender/marketer sites. All processor/blender/marketer sites were located in Western Washington. The samples collected were intended to represent the broadest average characteristics found in the used oil waste stream.

Table 2. Site Locations for Used Oil Samples

Sample ID	Site Name	Site Location	Date of Sample
TANK 7	Industrial Petroleum	1117 West Bay Rd. Olympia, WA 98505	10/24/90
TANK 8	Industrial Petroleum	1117 West Bay Rd. Olympia, WA 98505	10/24/90
TANK 9	Industrial Petroleum	1117 West Bay Rd Olympia, WA 98505	10/24/90
CP-107	Chemical Processors Pier 91	Pier 91 Seattle, WA 98505	11/02/90
NWES-AFT	Northwest Enviroservice	1500 Airport Way S Seattle, WA 98134	11/14/90
NWES-B4	Northwest Enviroservice	1500 Airport Way S Seattle, WA 98134	11/14/90
PRSI-1	Petroleum Reclaiming Services	3003 Taylor Way Tacoma,WA 98421	11/14/90
SWANSON1	Swanson Oil Co	1766 Ryan Road Buckley, WA 98321	11/28/90
PETENGR1	Petroleum Engineering	1517 Pease Sumner, WA 98390	11/30/90

Collection Methods. All samples were collected within the five-week period from October 24, 1990 to November 30, 1990. At each location, samples were collected in a single day. Chain of custody procedures were followed for all samples collected. All samples were stored on ice at 4°C until being transported to the Ecology/EPA Environmental Laboratory at Manchester, Washington.

Waste Oil Sampling Method. Samples of used oil were collected from processor/blender/marketer tanks using a clean, one liter wide-mouth jar.

The jar was lowered into each tank using clean monofilament nylon line. The jar, when full, was pulled back to the top of the tank. The contents of the jar were immediately split into two 40cc VOA bottles, two 125cc VOA bottles, and two 250cc squat jars. Each sample container was labelled with the site name, the date of sample collection and the time of sample collection. Any residual oil remaining in the 1-liter wide-mouth jar was shipped to Manchester Laboratory, along with the samples.

Analysis

Used oil sample was analyzed for the following characteristics and criteria; TCLP metals, volatile and semivolatile organics, halogenated hydrocarbons, and fish toxicity. (Three samples were not tested for fish toxicity). Analysis was not done for TCLP pesticides and herbicides. The static acute fish toxicity tests were run at one concentration (1000 mg/l), using rainbow trout (Oncorhynchus mykiss). A complete list of analytes, analytical methods, and laboratories used in the study are listed in Table 3.

Table 3. Analytical Methods for Used Oil.

Analysis	Method	Reference	Laboratory
TCLP			
Volatiles	GC/MS purge-trap	Fed. Reg. 1990	Kennedy/Jenks/
Benzene	(EPA SW846-1311)		Chilton
Carbon tetrachloride			
Chlorobenzene			
Chloroform			
1,2-Dichloroethylene			
Methyl ethyl ketone			
Tetrachloroethlyene			
Vinyl chloride			
Trichloroethylene			
Semivolatiles	GC/MS	Fed. Reg. 1990	Kennedy/Jenks/
o-Cresol	(EPA SW846-1311)		Chilton
p-Cresol			
1,4-Dichlorobenzene			
Dinitrotoluene			
Hexachloro-1,3-butadiene			
Hexachloroethane			
Nitrobenzene			
Pyridine			
Pentachlorophenol			
2,4,5-Trichlorophenol			
2,4,6-Trichlorophenol			
Metals	ICP, CVAA	Fed. Reg. 1990	Sound Analytical
Arsenic	(EPA SW846-1311)		Services
Barium			
Cadmium			
Lead			
Mercury			
Selenium			
Silver			
Halogenated	Extraction/combustion	Ecology,	Columbia Analytical
Hydrocarbons	ISE probe	1982	Services, Inc.
BIOASSAY			
Acute Fish Toxicity	Static Acute	Ecology,	Ecology/EPA
(@1000 mg/l)	(96-hr.)	1981	Manchester Lab

Quality Assurance

Quality control samples included field duplicates, method blanks, matrix spikes and spike duplicates, surrogate spike analysis, and reference standards.

Laboratory precision, calculated as matrix spike/matrix spike duplicate relative percent difference (RPD) values (range as percent of mean), was excellent for TCLP volatile analysis (3.5% average) and for semi-volatile analysis (8.7% average). The percent recoveries for all TCLP semi-volatiles and the TCLP volatiles were within the acceptable ranges. Overall precision (sample collection + laboratory), calculated from field duplicates (a single sample homogenized and split in the field) was good. The RPD for the three TCLP volatile compounds detected was 26%. There were no TCLP semi-volatile compounds detected.

RPD values for two field duplicates analyzed for halogenated hydrocarbons averaged 5%

The quality of TCLP **metals** data was reviewed by Craig Smith of the Ecology/EPA Manchester Laboratory. In the opinion of the reviewer all the metals data were acceptable for use without qualifications.

The TCLP organics data were reviewed by Stewart Magoon of the Ecology/EPA Manchester Laboratory. For the **semi-volatiles**, surrogate spike recoveries for these samples, the matrix spikes, and the method blanks are within QC recovery limits, with one exception. The 2-fluorobiphenyl surrogate recovery for one sample was below the lower QC limit. There may be a slight low bias to the results reported for this sample. Because all the surrogate recoveries were low, however, this bias was not severe enough to warrant data qualification. Matrix spike/spike duplicate recovery and precision data are acceptable and within limits for all the semi-volatile TCLP compounds. There were three outliers for Method 8270 QC limits for the spikes on one sample. These outliers do not signal the need for data qualifiers.

For the **volatiles**, surrogate spike recoveries for these samples, the matrix spikes, and the method blanks are within the recovery control limits that have been established for soil samples. The lowest surrogate recovery was 81% and the highest recovery was 109%. These are reasonable and acceptable recoveries even though control limits for "oil" samples have not been established. Matrix spike/spike duplicate recovery and precision data are acceptable and within QC limits. Note that no QC limits have been established for the percent deviation between MS and MSD recoveries, but the values are reasonable and acceptable.

Halogenated hydrocarbons were analyzed using the method described in WDOE 83-13, "Chemical Testing Methods for Complying with the State of Washington Dangerous Waste Regulation." The quality of the data was reviewed by Stuart Magoon of the Ecology/EPA Manchester Laboratory. In the opinion of the reviewer, the data is acceptable for use without the need for the addition of data qualifiers. The Quality Control Check recovery standards were 101%, 93%, and 99%. No chloride was detected in the Method Blank or instrument check blanks. The duplicate analyses were in good agreement with RPD values of 3.2 % and 0.4%.

Samples were tested for **toxicity** using the Static Acute Fish Toxicity Test method described in WDOE 880-12, "Biological Testing Methods." The data was reviewed by Margaret Stinson of the Ecology/EPA Manchester Laboratory and found to be acceptable for use without the need for the addition of data qualifiers. The LC50 for the reference toxicant used in the static acute fish toxicity test was within the normally expected range of values for the species used.

RESULT

Used oil samples taken at processor/blender/marketer sites represents a mix of many sources of used oil. While the majority of oil in the used oil waste stream may be from engine crankcases, it should not be assumed that the test results constitute a profile of crankcase oil. It should be remembered that used oil is broadly defined to include any oil that has been refined from crude oil, used, and as a result of such use, is contaminated by physical or chemical impurities.

The results of the halogenated hydrocarbon test and the fish toxicity test are summarized in Table 4.

Table 4. Summary of Halogenated Hydrocarbons and Fish Toxicity Test Results

Site Name	Total Halogens(ppm)	Fish Toxicity(@1000ppm)
Industrial Petroleum Tank 7	988	
Industrial Petroleum Tank 8		
Industrial Petroleum Tank 9	1200*	
Chemical Processors CP-107	623	Pass (3)
Northwest Enviroservice NWES-AFT	277	Fail (30)
Northwest Enviroservice NWES-B4	2320*	Pass (2)
Petroleum Reclamation PRSI-1	182	Pass (1)
Swanson Oil Co. SWANSON1	186	Pass (3)
Petroleum Engineering PERENGR1	373	Pass (0)

* These samples exceeded the 1000 ppm criteria.
___ Test not performed on this sample.
Note: Pass (3) means the sample passed the fish toxicity test and that there were three fish mortalities.

All values for halogenated hydrocarbons exceeded the 100 ppm regulatory threshold, making all the samples dangerous waste. Used oil samples containing up to 1000 ppm halogenated hydrocarbons can be managed under WAC 173-303-515, Special Requirements for <u>Used Oil</u> Burned for Energy Recovery. Used oil samples exceeding 1000 ppm are presumed to be mixed with a dangerous waste and must be managed under WAC 173-303-510, Special Requirements for <u>Dangerous Wastes</u> Burned for Energy Recovery. Three of the nine samples tested exceeded the 1000 ppm limit, and a fourth sample was only slightly below the threshold at 988 ppm. The halogenated hydrocarbon concentration ranged from a low of 182 ppm to a high of 2255 ppm.

Only one sample failed the acute fish toxicity test, in which all 30 fish died. All other used oil samples had 3 or less mortalities. At 1000 ppm the fish toxicity test is failed when at least 12 fish die in the 96 hour test.

The results of TCLP metals analyses are presented in Table 5. Only lead and barium were found at detectable levels in used oil. Barium occurred at low levels in 7 out of 9 samples tested, and ranged from below the detection limit up to 1.0 ppm. Lead was detected in only 2 of the 9 samples, and ranged from below the detection limit up to 0.1 ppm.

TABLE 5. Results of Analysis for TCLP Metals in Used Oil (mg/l)

SAMPLE ID	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
TANK 7	0.1U	0.3	0.1U	0.1U	0.1U	005U	0.1U	0.1U
Tank 8	0.1U	1.0	0.1U	0.1U	0.1	005U	0.1U	0.1U
TANK 9	0.1U	0.8	0.1U	0.1U	0.1U	005U	0.1U	0.1U
CP-107	0.1U	0.1U	0.1U	0.1U	0.1U	002U	0.1U	0.1U
NWES-AFT	0.1U	0.3	0.1U	0.1U	0.1	002U	0.1U	0.1U
NWES-B4	0.1U	0.5	0.1U	0.1U	0.1U	002U	0.1U	0.1U
PRSI-1	0.1U	0.2	0.1U	0.1U	0.1U	002U	0.1U	0.1U
SWANSON 1	0.1U	0.2	0.1U	0.1U	0.1U	002U	0.1U	0.1U
PETENGR1	0.1U	0.1U	0.1U	0.1U	0.1U	002U	0.1U	0.1U
Regulatory Limit	5.0	100	1.0	5.0	5.0	0.2	1.0	5.0

U=Not detected at detecting limit shown

As = Arsenic	Pb = Lead
Ba = Barium	Hg = Mercury
Cd = Cadmium	Se = Selenium
Cr = Chromium	Ag = Silver

The results of TCLP organics analysis of used oil samples are presented in Table 6. Four TCLP organic compounds were detected in used oil. These included cresol (total), benzene, methyl ethyl ketone and tetrachloroethylene. Cresol was detected in 6 out of 9 samples, ranging from a low of 91 mg/l to a high of 1320 mg/l. Benzene was detected in 6 out of 9 samples, ranging from a low of 210 mg/l to a high of 1200 mg/l. Methyl ethyl ketone was detected in 2 out of 9 samples, ranging from a low of 320 mg/l to a high of 420 mg/l. Tetrachloroethylene was detected in one sample at 33 mg/l.

TABLE 6. Results of TCLP Organics in Used Oil (ug/l)

	T-7	T-8	T-9	CP-107	NWES-AFT	Reg. Limit
Semivolatiles						
Cresol (total)	440	1320	300	300	100U	200,000
1,4 Dichlorobenzene	100U	100U	100U	100U	100U	7,500
2,4 Dinitrotoluene	100U	100U	100U	100U	100U	130
Hexachloro-1,3-butadiene	100U	100U	100U	100U	100U	3,000
Nitrobenzene	100U	100U	100U	100U	100U	2,000
Pentachlorophenol	500U	500U	500U	500U	500U	100,000
2,4,5 Trichlorophenol	500U	500U	500U	500U	500U	400,000
2,4,6 Trichlorophenol	100U	100U	100U	100U	100U	2,000
Volatiles						
Benzene	50U	640	1200	430	50U	500
Carbon tetrachloride	50U	50U	50U	50U	50U	500
Chlorobenzene	50U	50U	50U	50U	50U	100,000
Chloroform	50U	50U	50U	50U	50U	6,000
1,2 Dichloroethane	50U	50U	50U	50U	50U	500
1,1 Dichloroethylene	50U	50U	50U	50U	50U	700
Methyl ethyl ketone	420	100U	100U	320	100U	200,000
Tetrachloroethylene	50U	50U	50U	50U	50U	700
Vinyl chloride	100U	100U	100U	100U	100U	200
Trichloroethylene	50U	50U	50U	50U	50U	500

U = Compound not detected at detection limit shown
J = Estimated value

TABLE 6 (continued)

	NWES-B4	PRSI-1	SWANSON1	PETENGR1	Reg. Limit
Semivolatiles					
Cresol (total)	100U	100U	91J	370	200,000
1,4 Dichlorobenzene	100U	100U	200U	100U	7,500
2,4 Dinitrotoluene	100U	100U	200U	100U	130
Hexachloro -1,3-butadiene	100U	100U	200U	100U	500
Hexachloroethane	100U	100U	200U	100U	3,000
Nitrobenzene	100U	100U	200U	100U	2,000
Pentachlorophenol	500U	500U	1000U	500U	100,000
2,4,5 Trichlorophenol	500U	500U	1000U	500U	400,000
2,4,6 Trichlorophenol	100U	100U	200U	100U	2,000
Volatiles					
Benzene	50U	400	210	270	500
Carbon tetrachloride	50U	50U	50U	50U	500
Chlorobenzene	50U	50U	50U	50U	100,000
Chloroform	50U	50U	50U	50U	6,000
1,2 Dichloroethane	50U	50U	50U	50U	500
1,1 Dichloroethylene	50U	50U	50U	50U	700
Methyl ethyl ketone	100U	100U	100U	100U	200,000
Tetrachloroethylene	50U	50U	50U	33J	700
Vinyl chloride	100U	100U	100U	100U	200
Trichloroethylene	50U	50U	50U	50U	500

U = Compounds not detected at detection limit shown
J = Estimated value

DISCUSSION

Tables 4, 5, and 6 present all the test results for used oil tested as part of this study. Test results which exceeded the regulatory threshold are bold typed in these tables. Nine used oil samples were analyzed in this study for TCLP metals, volatiles, and semivolatiles, halogenated hydrocarbons, and fish toxicity.

Of the nine samples analyzed for this study, none of them failed for TCLP metals content. Barium and lead were the only two TCLP metals found in used oil, and they were present in concentrations well below the regulated threshold. Barium ranged in concentration from below detection up to 1.0 ppm, and lead ranged in concentration from below detection up to 0.1 ppm.

Two of the used oil samples contained TCLP volatile compounds in concentrations exceeding the regulatory threshold. The offending constituent was benzene which is regulated at 0.5 ppm benzene in the extract. The two samples which exceeded the threshold contained 0.64 ppm and 1.2 ppm benzene. Methyl ethyl ketone was detected in two samples, but below the regulatory limit. Tetrachloroethylene was detected in one sample. All other volatile compounds were below the detection limit.

None of the used oil samples contained TCLP semivolatile compounds in concentrations exceeding the regulatory thresholds. Cresols were detected in six of the samples but not in concentrations exceeding the regulated threshold. All other semivolatile compounds were below the detection limits.

All nine used oil samples exceeded the 100 ppm regulatory threshold for halogenated hydrocarbons, WAC 173-303-102, making all samples dangerous waste. Three of the nine samples exceeded the 1000 ppm criteria for oil being burned for energy recovery (WAC 173-303-515) and a fourth sample was slightly below the threshold. The three samples contained 1200, 1760, 2255 ppm total halogens.

One of the used oil samples failed the acute fish toxicity test, killing all 30 fish in the 96 hour test. All other samples experienced 3 or less mortalities in this test. (Three samples were not subjected to the fish toxicity test.)

Other studies of used oil from engine crankcases indicate that elevated levels of metals, particularly lead and chromium, may be present in the waste stream as leachable metals. This study did not find that leachable metals were present in used oil samples above the regulatory threshold. Used oil samples analyzed in this study were collected from large tanks containing used oil from many generators, presumably representing a broad cross-section of the waste stream. The analytical results on this study suggest that used oil may not designate as dangerous waste for the presence of TCLP metals.

In this study, benzene was found to be present in concentrations exceeding the regulatory limit in 2 of the 9 samples. Other studies also documented the presence of benzene in used oil, sometimes at much higher frequency. Since benzene is not a constituent of motor oil, it is believed that gasoline is the probable source of the benzene in used oil. With the exception of benzene, no other TCLP organics were found at regulated levels in any of the samples.

CONCLUSIONS

1. Barium and lead were detected in used oil at levels below TCLP regulatory levels. Other TCLP metals were not detected in used oil.

2. Benzene was the only TCLP organic compound found to exceed the regulatory limit. Benzene exceeded the TCLP regulatory limit in two out of nine processor/blender/marketer used oil samples. Therefore, 22% of the samples tested designated as dangerous waste, based on TCLP results for organics.

3. Halogenated hydrocarbons exceeded the regulatory limit of 100 ppm for all nine samples tested. Therefore, 100% of the samples tested designated as persistent dangerous waste under the state's definition of persistence (WAC 173-303-102). In addition, three out of nine samples contained halogenated hydrocarbons above 1000 ppm. Used oil containing more than 1000 ppm halogenated hydrocarbons is considered Dangerous Waste Fuel and must be managed under WAC 173-303-510.

4. One out of nine used oil samples was found to be acutely toxic to fish. The one sample which failed the acute toxicity test was not a dangerous waste for any other reason, including TCLP metals or organics, or for halogenated hydrocarbons.

RECOMMENDATIONS FOR ECOLOGY ACTION

1. Prepare a Focus sheet on used oil for the benefit of generators, encouraging them to segregate their used oil from other wastes they generate in their business.

2. Prepare an article for Shop Talk and other publications which explains the problem of mixing wastes with used oil.

3. Consider more inspections of the used oil marketers/blenders by the regional offices. The purpose of such inspection should include the sampling and testing of used oil to confirm that dangerous waste fuel is not being blended and marketed under WAC 173-303-515 as used oil.

4. Sample and test used oil from crankcases to determine if the halogenated hydrocarbons are inherent in used oil, or if their presence is the result of subsequent contamination.[1]

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[1] The need for this additional testing will be evaluated after EPA publishes the final used oil rule (expected) in May 1992.

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